Patani States, in which souls and ghosts are dealt with; a consideration of ghosts and spirits unconnected with material bodies will be published in another part.

The work is admirably printed, and the illustrations are excellent. This first part reflects great credit on the University Press of Liverpool.

ELECTROCHEMISTRY IN AMERICA.

THE third meeting of the American Electrochemical Society took place in New York on April 18. Three meetings may seem rather a small number for a society which has been in existence for more than eighteen months, but the society, which has members from all parts of the United States, only meets once in six months, and the meetings assume the form of a congress, which lasts several days. This style of meeting, which might be compared to the annual meeting of the Society of Chemical Industry, in which members from all parts of the country meet together each year in a different town, partly for work and partly for social intercourse, has certain obvious advantages, in that country as well as town members are able to attend; there is, however, one disadvantage, and that is that papers are only published once in six months. The transactions of the society are also only published once in six months, hence they contain the concentration of six months' work.

The presidential address of Dr. Joseph W. Richards, an abridgment of which is printed below, contains several points of considerable interest. One thing which will strike British electrochemists is that although the Americans have made great progress in the industrial applications of electrochemistry, yet they have to admit that they owe their present position in a large measure to foreign trained electrochemists. Dr. Richards mourns that they are vastly behind the Germans in the number of their chairs and laboratories of electrochemistry. How much more, then, should we in this country mourn—*we have not a single chair devoted to the teaching of electrochemistry*, and there are only two or three laboratories in the whole kingdom.

It is often said that, having very little water power in this country, we can never expect to compete industrially with other countries in electrochemical processes. Dr. Richards remarks that although all countries have not Niagaras, they have gas-engines, and he points out some of the sources of gas supply. Finally his remarks upon the value of literature, *good, sound literature*, are worth consideration. Where is the British electrochemical literature to be found?

To live is to progress, and to progress is to live. A science which does not progress petrifies. The science of electrochemistry has progressed so magnificently in the last decade that a mere catalogue of its achievements would be a monumental compilation. Abler and better-informed pens than mine have given to us recently, in presidential addresses and in careful reviews, the detailed history of this progress. I do not intend to attempt that task anew this evening; my theme is an analysis of the *conditions which make for progress*, and which I hope to make clear in all their bearings on electrochemical science.

I place discovery of new facts in electrochemical science as the corner-stone of progress in our science. Given a freshly-flowing current of new electrochemical facts, and all the other elements of progress have a chance to exist. No less certain than this is the location of the birthplace and the identity of the sponsors of these newly-born facts. The birthplaces are chemical, electrical and physical laboratories; the sponsors are the investigators, the searchers after truth—the professors, students, employees, private investigators, and all who with the insatiable thirst for more knowledge are pushing back the thick curtain of the unknown which hems us in so closely on every side. The elect among these workers, the highly-favoured few, are the professors of electrochemistry provided with well-equipped electrochemical laboratories. They are in the position to do or to direct the most valuable investigations, and are also under the moral obligation to publish freely to the world all that they discover. The giants of the electrochemical fraternity are in this class: Davy, Faraday, Bunsen, Arrhenius, van 't Hoff, Ostwald, Nernst, Moissan. The labours of such workers, given to the world in their publications, form the *body* of electrochemical science, and their thoughts—its *soul*. Such are the heroes of science; men who work for the work's sake, who sacrifice time, money, and often health, to increase the boundaries of our knowledge, and then keep nothing back.

The German-speaking countries count up alone at their universities and technical schools fifteen chairs of electrochemistry and twelve electrochemical laboratories. These, we all know it, have been the source of the greater part of the advance of electrochemical science in the last ten years. The whole industrial electrochemical world is debtor to the European electrochemical laboratories and their workers, and how can that debt be requited? Surely not by selfishly using all the facts and holding fast all the material benefits. Not only common gratitude but also self-interest unite in recommending to the captains of electrochemical industry that more such laboratories be built and more such chairs endowed; money thus spent will be seed which will return many fold its value to the industry. America has boasted that it is "The Electrochemical Centre of the World." It may be so, in the development of electrochemical industries, in the amount of power used and material products turned out; but is it not a fair question to ask "Where are the professors of electrochemistry at our universities and how many electrochemical laboratories are at their command?" Are we not out of comparison with Germany in that respect—but I trust not hopelessly so? Our present flourishing condition industrially is largely due to our foreign-trained electrochemists and our imported literature. Shall we not, through shame at contributing so little ourselves to that literature, soon begin to establish chairs of electrochemistry and build well-equipped laboratories to go with them? Then our boast might begin to be more than the empty boast of a successful money-maker; then we may begin to be an *illuminating* centre radiating knowledge to the rest of the world.

In place of professors and professional laboratories, however, America is blessed with another class of investigators who are no less industrious in acquiring facts, and to whom a large part of our commercial success is directly ascribable; I refer to the small army of patient investigators in the laboratories of our industrial plants, who are searching over ground not yet explored and accumulating facts of value in their special industrial lines. The expense of such work is borne by the corporation for which they labour, and the work itself is in reality an investment made in the hope of yielding financial reward.

By means of facts, correlating, discussing and deducing therefrom, we arrive at a knowledge of the laws of science, the rules governing its various phenomena and according to which its manifestations invariably proceed. Such deductions are the goal of pure science; they contain no element of speculation, hypothesis or theory, and represent man's deepest insight into the phenomena of nature.

The indefatigable Faraday discovered our first fundamental laws. Ohm and Joule added to them, and numerous later investigators have contributed, but we must not make the mistake of thinking that there remains very little more in the nature of generalisations to be discovered; we could not make a greater mistake. If facts are being discovered, the recognition of unforeseen generalisations and the establishing of new laws are bound to follow, and thus the science reaches its highest consummation.

Such discoveries are usually the privileges and the perquisites of the experimenter and investigator, if so be that he is likewise a thinker. He gets the facts at first hand, and has the first chance to deduce new laws. The electrochemist not blessed with laboratory facilities has, however, free entrance to this field. He may be only a student, a looker-on at what others are doing, a reader of the newly-discovered and recorded facts, but if he is at the same time a thinker, a compiler, an analyst with the power of collating, dissecting and deducing, he may in the seclusion of his study discover laws which escape the observation of others less studious, and thus render a service of the highest value to the science.

As soon as facts accumulate and laws are discerned, the man of science inevitably begins to reflect on the why and the wherefore. He commences to search for relations, to imagine connections and dependencies, and to make pictures of the mechanism of the phenomena. It was thus that Dalton imagined the atomic theory to account for the fact of chemical combination in simple multiple proportions, that Arrhenius hit upon the dissociation theory to account for the increase of molecular conductivity with increasing dilution, that Nernst worked out the solution-pressure theory to explain the generation of current in the galvanic cell. Thus there are theories and theories, some poor, some good, and some almost perfect in their applicability, since, *granting their premises*, they give an explanation satisfactory to the mind of all observed phenomena.

Such theories are not only allowable, but necessary. We must have them, much as an artisan must have a working drawing of the machine he will construct; the drawing is but paper and ink, which never moves or works, but it guides the workman in putting his ideas into realities. So theories help us to handle mental conceptions as if they were concrete things, and thus to imagine and discover relations and generalisations which would otherwise be beyond our mental grasp.

The danger to the development of a science comes when a theory, by being believed too implicitly and by not being open to constant revision, becomes a strait-jacket for the growing science. Like a "creed outworn," it stifles criticism, warps the judgment, engenders blindness and bias in its adherents and undue hostility and acrimony in its opposers. We should be slow in revising our theories, or in discrediting a theory which has done us good service in its day, just as we are conservative in correcting our "confessions of faith" or indulgent and sympathetic with the weaknesses of a faithful old servant; but, after all, when a theory has come to be considered so firmly fixed as to be above criticism, or so certainly true as to be above the possibility of revision, or so well-established as to thunder its excommunications on those who dare to think or believe otherwise—such a theory had better be placed at once in the museum of scientific petrifactions, where it properly belongs, and where it can do no further harm.

If science is progressing, theories must progress too; they will be outgrown, much light will give way to more light, imperfect pictures of phenomena founded on crude assumptions must be replaced by better pictures corresponding more accurately to the newer and the larger truth, and then progress begins anew.

All theories have been of some use in their day; they have helped men to grasp concretely evanescent immaterial phenomena, they have very often been splendid guides to further experiment and new discoveries, they have at times been so helpful that many have mistakenly thought them infallible, and lastly, they have been stepping-stones to better theories. One great hindrance to scientific progress is the common human weakness of becoming partisans of a theory. Who is not familiar with the well-meaning theoriser whose mental vision is so biased that he refuses or is incompetent to give a fair reception to new facts and theories; or who has not met the egotistical speculator who experiments and makes researches not to discover truth, but to prove his pet theory? Thus the warmest friends of a theory are often its worst enemies, and by their blind partisanship lay obstacles in the path of scientific progress instead of being the leaders which they might be.

To make a specific application of these remarks, who has not felt that the most effective blows dealt the present theory of electrolytic dissociation have come from the excessive zeal of its warmest adherents? There are scientific zealots as well as religious bigots, and the one does as much harm to the progress of true science as the other does to the development of pure religion.

The fundamental conceptions of any and every theory must always be open to correction and revision, and thus progress will be rendered easy. If new facts appear which contradict our theories, let us welcome them, like loyal lovers of the truth should. The theory of electrolytic dissociation is being saved by being modified and revised, it is being transformed into a more perfect mirror of the truth as we now conceive it, and thus only is it retaining its usefulness and aiding in scientific progress.

Power alone is apt to be regarded as the first desideratum for the success of electrochemical processes, but knowledge, thinking power and industry are more primary factors. Given these, crude materials to work with will be found on every hand, and power sufficient will be created if it is not to be found.

A few words, however, about this question of the necessary cheap power. This item in manufacturing cost is of variable importance in electrochemical processes; in some it may form three-quarters of the total cost of the process, in others perhaps only one-quarter. The former are frequently compelled to move to the cheapest power, in order to exist at all, while such as the latter may take into account many other considerations, and find it cheaper for them to locate at more expensive powers. Niagara Falls is the most accessible of our great water powers, and has therefore drawn into its fold the majority of our electrochemical industries. But another source of surplus power is distributed over a large part of our country, in a condition at present as undeveloped as was Niagara power when Columbus touched our shores. I refer to the surplus power from blast-furnaces, obtainable by using gas-engines. Every blast-furnace burns its gases to heat its blast and to raise steam for its power. The two-thirds of its gases used for the latter purpose generate just about the power needed for the blowing-engines, pumps, hoists, &c., an amount equal on an average to 2500 horse-power for a furnace making 500 tons of iron per day. If the gas thus used was used in gas-engines, there would be an average surplus power, over and above all the requirements of the furnace itself, of 10,000 horse-power. The gas-engine plant needed to produce this power does not cost more than 50 dollars per horse-power investment, which compares favourably with the cost of developing water-powers, which vary from 25 dollars to 100 dollars per horse-power. It is thus deducible that there are scattered over the United States, in some of our most flourishing industrial centres, undeveloped powers which aggregate more than 1,000,000 horse-power, which can be developed at no more cost than the average water-power, can be generated just at the spots where they can be most favourably utilised, and without any more drain on our natural resources than the harnessing of a new water-power—for not a pound of coal more would have to be burnt than is used at present.

Other possible sources of power are the waste surplus gases from by-product coking ovens, and the utilisation of gas-producers, using cheap, almost waste, coal, in connection with gas-engines. Power therefore is available in immense quantities in places and in countries not blessed with Niagaras in their midst, and the industrial development of such sources will be one of the most marked industrial movements of the next ten years.

And now, let us inquire, how is this increasing development of power and its increasing application to industrial purposes best promoted by the electrochemists themselves. Undoubtedly, it is by the intimate and cordial cooperation of theoretical with practical electrochemists. This is attained by many agencies, but the most potent are research companies and our Electrochemical Society.

Such organisations as research companies, formed explicitly to combine research with practical application, are novelties in the industrial world which have originated with, and are almost peculiar to, electrochemistry. They invent, investigate and develop electrochemical process, and furnish facilities to would-be experimenters whose ideas might otherwise remain still-born. Such companies deserve the hearty support of all electrochemists, for they are injecting new life into the industry. May we have more such, scattered all over our land to nurse and develop quickly into active being the many electrochemical processes which *are to be*.

The factors which promote increasing applications of electrochemistry are therefore cheap and accessible power, experimentation on a semi-industrial scale, men with heads full of ideas and inventiveness in applying them to the industrial needs of the country, more research companies and a further cultivation of the beneficent results of our society meetings.

By thus doing, cheap raw materials will be converted by the electrochemist into valuable products with constantly increasing ease and constantly decreasing cost, and thus electrochemistry will achieve its great *raison d'être* by increasingly ministering to the needs, the comforts and the pleasures of life, and thus it will become an increasingly important factor in social progress.

No modern science can progress if it adopts the mediæval practice of the alchemists, and carefully guards its wisdom for the exclusive use of the initiated. Widespread dissemination of the literature of our science, not only among our own fraternity, but among educated people in general, and even down to the rising generation of expectant men of science, is as necessary to our progress as is the recruiting of the human family to the preservation of the race.

The literature of our science consists of transactions, journals, treatises, monographs and text-books. Without these, and without the constant extension, improvement and dissemination of the same, our science would soon be dead indeed.

The transactions of our societies are the standing record of papers and discussions presented at our meetings. The contents represent the labours of many heads and hands, and the opinions of many minds. As such, they form a permanent record of the latest advances and the best thought in electrochemical lines. They are the reservoirs of information from which the other literature of the science, such as treatises and monographs, is largely compiled. They are of particular value to people who cannot personally attend the meetings which they report. Their value is augmented by being quickly printed and distributed, and the publication committees having that task in their charge should receive the cooperation of all authors in their efforts to prevent the transactions from becoming ancient history before they are issued. We may be pardoned referring with a little pride to the fact that the report of our Niagara meeting was distributed seven weeks from the close of the meeting, and that 25 per cent. of the papers presented at this, our most notable New York meeting, were in print before the meeting began.

The increasing membership of our societies, and the placing of such transactions in scientific and public libraries, are potent means towards interesting and instructing the world in electrochemistry, and recruiting the army of electrochemical workers.

Our text-books, intended to give beginners their first ideas of electrochemistry, should be most carefully written. Nothing sticks so permanently in the mind as a correct idea taken in youth from a good text-book—except an incorrect idea taken from a bad one, and I think that the latter often sticks the hardest. It used to be remarked that every professor elected to a chair of mineralogy in Europe felt himself expected to write a treatise on crystallography—and he generally wrote it; it is, of course, an exaggeration to say that every privat-docent elected to lecture on electrochemistry writes a text-book on the elements of the science, but it is an exaggeration with a grain of truth in it. There are entirely too many imperfect or partisan or downright execrable text-books of this kind; one good one, written by a master, is worth more than all of these poor ones put together. Electrochemistry should also be better presented in the elementary text-books of chemistry and electricity. The interrelation of these subjects is so intimate that the fundamentals of either necessarily include some of the fundamentals of the other, and beginners are wonderfully apt at comprehending the essential fundamental facts if they are skilfully presented. I recall to mind a very complete modern text-book of inorganic chemistry, written by a splendidly-informed chemist, in which the electrochemical part was turned over to an assistant, and, as a consequence, abounds in misstatements. We cannot afford to have our students started wrongly, and it is therefore of the highest importance that our text-books, while being as brief as is necessary, should be as accurate as is possible.

NOTES.

THE monument which was unveiled last month at Bonn, in honour of Prof. Kekulé, stands away from the city and just in front of the building of the chemical laboratories of the University of Bonn, the place in which Kekulé laboured and taught for so many years and with such pronounced and conspicuous success. The statue stands on a granite pedestal, and is life-size and of bronze. On each side of the sculptured figure of Kekulé is a sphynx. The character of the man, simple and unpretentious, yet convincing, is well brought out, and some of his greatest scientific achievements are clearly represented in relief on the pedestal. At the unveiling ceremony many universities and scientific bodies, foreign as well as German, were represented, and so also were numerous firms engaged in the chemical industry.

THE third International Mathematical Congress has been arranged to take place in Heidelberg on August 8–13 of next year. The congress will be divided into six sections, dealing respectively with arithmetic and algebra, analysis, geometry, applied mathematics, history of mathematics, and pædagogics. In addition to the business and sectional meetings, there will be conversaziones, a banquet, and an excursion up the Neckar, and illumination of the Castle. The year 1904 is the centenary of the birth of C. G. J. Jacobi, and the occasion will be celebrated in connection with the congress by the publication of a memorial volume on Jacobi under the authorship of Prof. Königsberger. The secretarial work of the congress is in the hands of Prof. A. Krazer, of Carlsruhe.

THE Anthropological Institute announces that Prof. Karl Pearson, F.R.S., has accepted its invitation to deliver the annual Huxley memorial lecture this year. The lecture will be delivered on Friday, October 16, at 8.30 p.m., in the lecture theatre of Burlington House. Prof. Pearson has chosen for his subject, "On the Inheritance in Man of Moral and Mental Characters, and its Relation to the Inheritance of Physical Characters."

A REUTER message from Strassburg states that the second International Seismological Conference, the object of which is to found an association for the study of seismological phenomena in countries interested in the question, was opened there on July 24. Twenty States were represented. The Statthalter of Alsace-Lorraine, who is patron of the conference, welcomed the delegates in the name of the German Empire.

THE Government has appointed Captain Harry Mackay, a Dundee whaling master, to the command of the *Discovery* relief expedition. The relief ship *Terra Nova* will be manned by an entirely civilian crew, chiefly whalemen. The ship is expected to be ready for sea in about a month, and it has been decided, instead of making a long passage round the Cape, to proceed by the Suez Canal. Arrangements will be made to ensure that, after passing Gibraltar, the *Terra Nova* will be towed by fast vessels of the Royal Navy attached to the Mediterranean and East India stations. The relief ship will proceed to Hobart, where she will be joined by the *Morning*.

THE bust of the late Sir William Flower, prepared for the Flower Memorial Committee by Mr. Thomas Brock, was formally presented to the trustees of the British Museum, at the Natural History Museum, on Saturday last. Dr. P. L. Sclater gave an address in the name of, and on behalf of, the 185 subscribers to the fund.